Capturing Crosslinguistic Generalizations: Multilingual Metagrammars

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Goals of This Talk

1. Give a brief overview of some aspects of computational linguistics
2. Discuss some recurring properties of languages
3. Present an approach that captures cross-linguistic generalizations

Outline

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What is Computational Linguistics?

Theoretical Computational Linguistics

- formal theories of linguistic knowledge
- computational models of human cognition
- computational psycholinguistics

Applied Computational Linguistics

- human language technology / natural language processing
- human-machine interaction
- dealing with large corpora (internet)
- machine translation

Machine Translation (MT)

- A real-world example (German Historical Museum):

(1) Königin Victoria aß gerne und viel.
Queen Victoria ate with-pleasure and lots

(2) Queen Victoria liked to eat and she ate a lot.

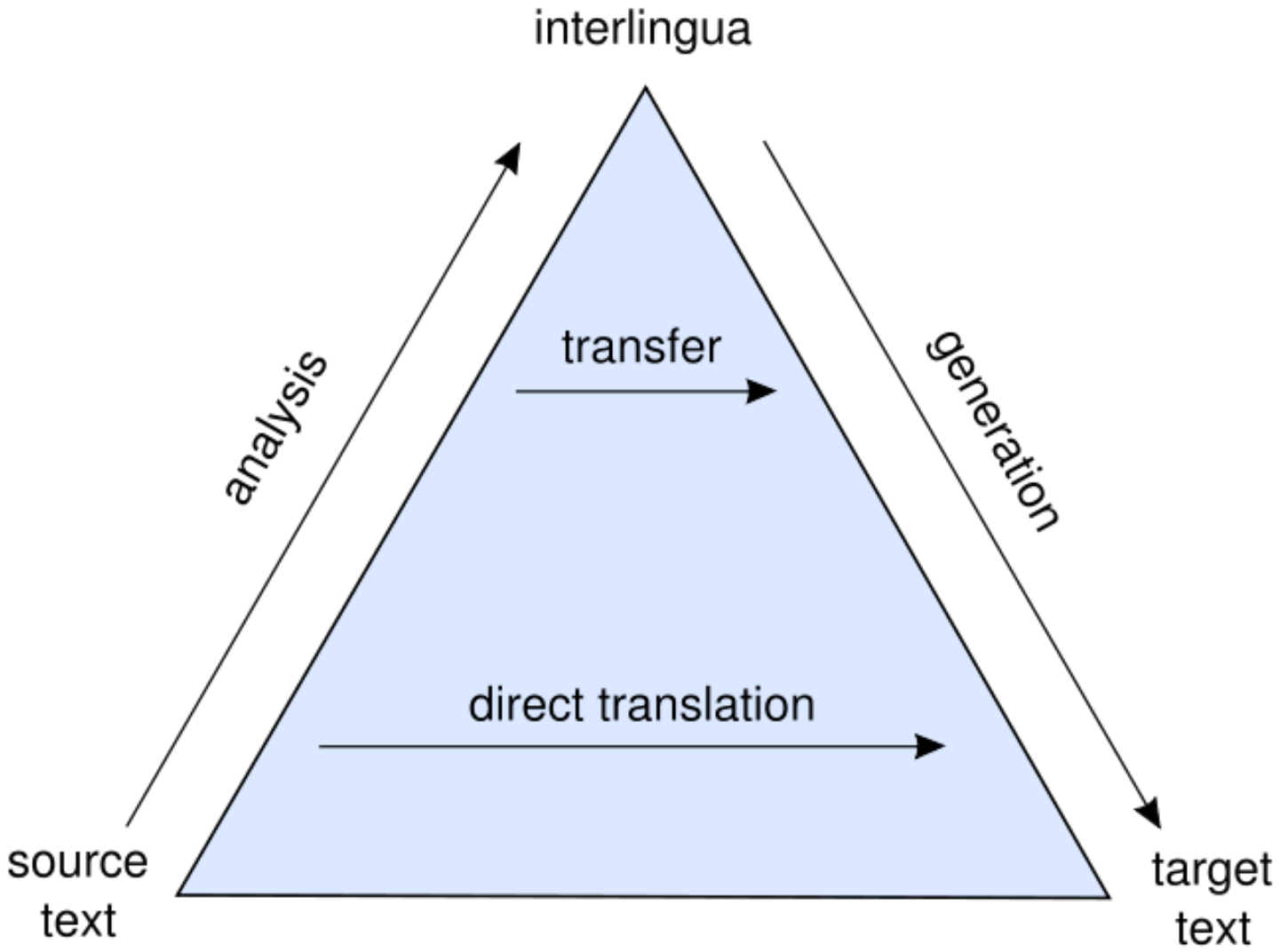
- A simpler example:

(3) She likes to eat. (English)

(4) Gerne isst sie. (German)
with-pleasure eats she

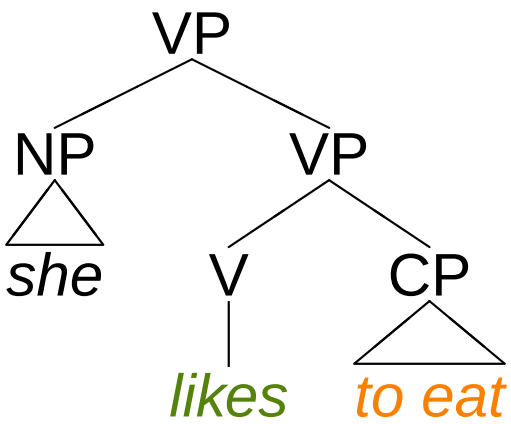
- What steps are needed to get from (3) to (4)?
- identifying words, translating them
- But looking up words is not enough!

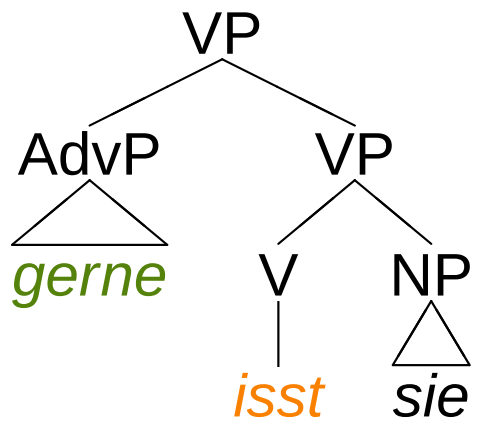
MT – Different Methods of Transfer



MT – The Need for Grammars

- Independently of the translation strategy, idiosyncrasies of the source and target language have to be respected.





Grammars in Computational Linguistics

- Grammars describe the linguistic properties of a language in a concise way.
- In most CL applications, grammars are needed
  - hand-crafted grammars
  - grammars that have been extracted from (hand-crafted) corpora
- Developing such grammars is costly and slow.

Metagrammars

- *Meta*grammars describe grammars
- They contain partial descriptions of syntactic structure, which are compiled into actual grammars
- Elements of the syntactic descriptions can be explicitly reused:
  - within a grammar (e.g., properties of noun phrases, argument structures)
  - across grammars (this talk)

Motivation for Multilingual Metagrammars

Traditional focus: Grammar development

- guarantee consistency and coverage

Our focus: Linguistic generalizations

- develop new grammars for new languages quickly

Our approach: Find cross-linguistic and framework-neutral syntactic invariants

Cross-linguistic and cross-framework syntactic invariants

- Finite number of syntactic categories (NP, PP, etc.)
- Notion of subcategorization (intransitive, transitive, etc.)
- Finite number of syntactic functions (subject, object etc.)
- Existence of valency alternations (passive, causative, etc.)
- Argument realization, word order effects (such as V2 or *wh*-movement)

Outline

Scrambling in Korean

- Korean is a verb-final language with relatively free word order.
- Noun Phrases exhibit *scrambling*.
- *Scrambling* is the permutation of constituents (arguments, adjuncts).

(5) [hyeongi_gongjangi]$_1$ [samchonege]$_2$ [gagureul]$_3$
a_local_company$_{nom}$ the_uncle$_{dat}$ furniture$_{acc}$
[samiljeone]$_4$ baedakhaessda.
three_days_ago delivered_has.
'A local company has delivered the furniture to the uncle three days ago'

- 4! = 24 word orders are acceptable for this sentence in Korean.

Scrambling in German

- German is another SOV language with scrambling.

(6) . . . (dass) [eine hiesige Firma]$_1$ [dem Onkel]$_2$ [die Möbel]$_3$ [vor drei Tagen]$_4$ zugestellt hat.

. . . (dass) [vor drei Tagen]$_4$ [dem Onkel]$_2$ [eine hiesige Firma]$_1$ [die Möbel]$_3$ zugestellt hat.

. . . (dass) [die Möbel]$_3$ [dem Onkel]$_2$ [vor drei Tagen]$_4$ [eine hiesige Firma]$_1$ zugestellt hat.

. . . (dass) [dem Onkel]$_2$ [vor drei Tagen]$_4$ [eine hiesige Firma]$_1$ [die Möbel]$_3$ zugestellt hat.

⋮

. . . that a local company$_1$ has delivered the furniture$_3$ to the uncle$_2$ three days ago$_4$.

The Verb-Second Phenomenon (V2)

(7) a. [Auf dem Weg] sieht [der Junge] [eine Ente].
on the path sees the boy a duck
'On the path, the boy sees a duck.'

b. * [Auf dem Weg] [der Junge] sieht [eine Ente].
on the path the boy sees a duck
Int.: 'On the path, the boy sees a duck.'

- Finite verb is required to be located in "second position"
- V2 languages include German, Dutch, Yiddish, Frisian, Icelandic, Mainland Scandinavian, and Kashmiri
- Small-scale linguistic variation: Behavior in embedded clauses differs

V2 in German

(8) a. Der Junge sieht eine Ente auf dem Weg.
the boy sees a duck on the path
'On the path, the boy sees a duck.'

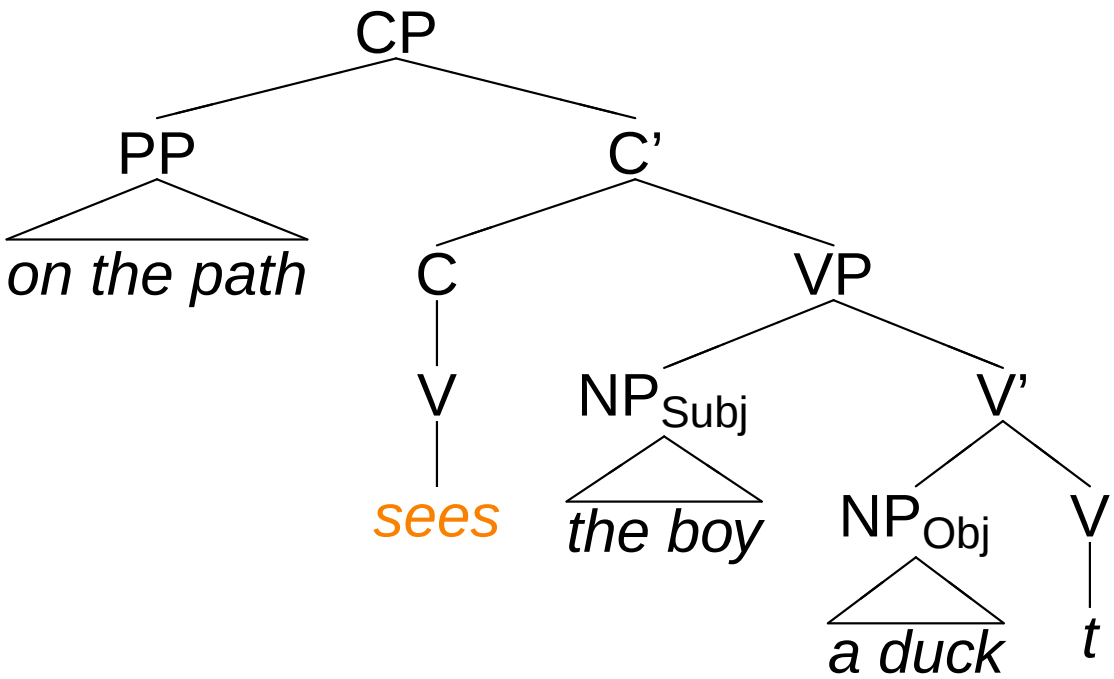
b. . . . , dass der Junge auf dem Weg eine Ente sieht.
. . . , that the boy on the path a duck sees
'. . . , that the boy sees a duck on the path.'

- Main clauses exhibit V2 in German
- Embedded clauses with complementizers are verb-final

	Main Clauses	Embedded Clauses
German	V2	V-Final

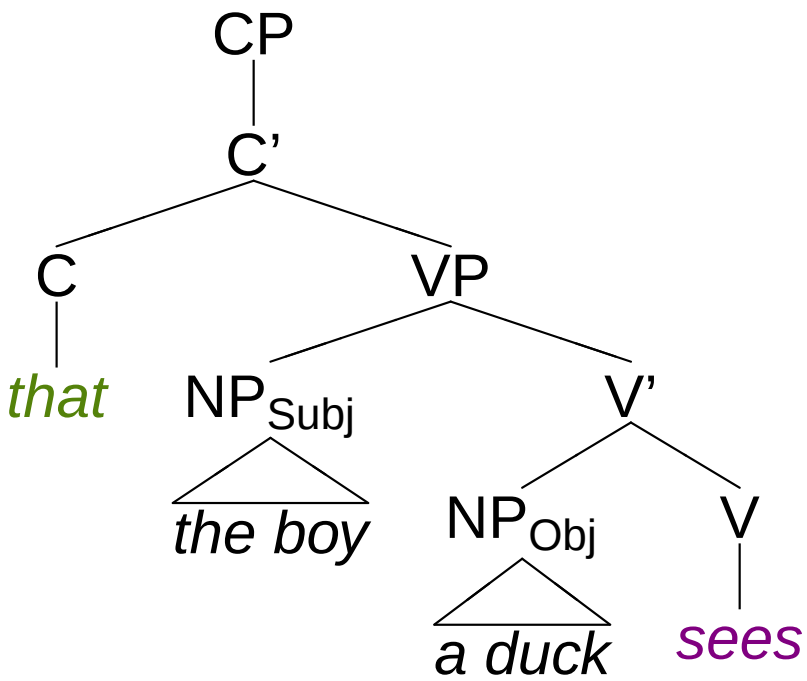
A First Explanation of German Word Order

- German is a verb-final language.
- In main clauses, the verb moves to the complementizer position, and some constituent *topicalizes* (moves) to its specifier.



A First Explanation of German Word Order - cont.

- In embedded clauses, the overt complementizer blocks this.



V2 in Yiddish

(9) a. Oyfn veg zet dos yingl a katshke.
on-the path sees the boy a duck.
'On the path, the boy sees a duck.'

b. . . . , az dos yingl zet a katshke oyfn veg
. . . , that the boy sees a duck on-the path
'. . . , that the boy sees a duck on the path.'

- As a verb-second language, Yiddish main clauses exhibit V2
- Yiddish embedded clauses must also be V2

	Main Clauses	Embedded Clauses
German	V2	V-Final
Yiddish	V2	V2

Summary: Two Puzzles

1. Scrambling

- free reordering of constituents in Korean, German, . . .

2. Verb-Second Constraint

- finite verb in second position in main clauses
- but in embedded clauses, the behavior differs
- What is the cross-linguistic core of this phenomenon?

Outline

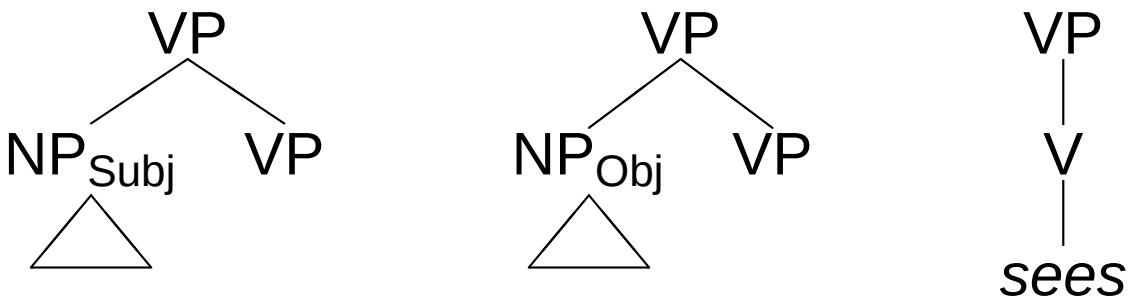
Some Assumptions

- We are working with Tree-Adjoining Grammar (not introduced here).
- All verbal phrasal nodes are called VP, they will be distinguished by certain features.
  - This is necessary to capture freer word order.
  - Continuation of the distinction between V', VP, I', IP, C', CP, etc.
- Modifiers are not currently part of the (meta)grammar.

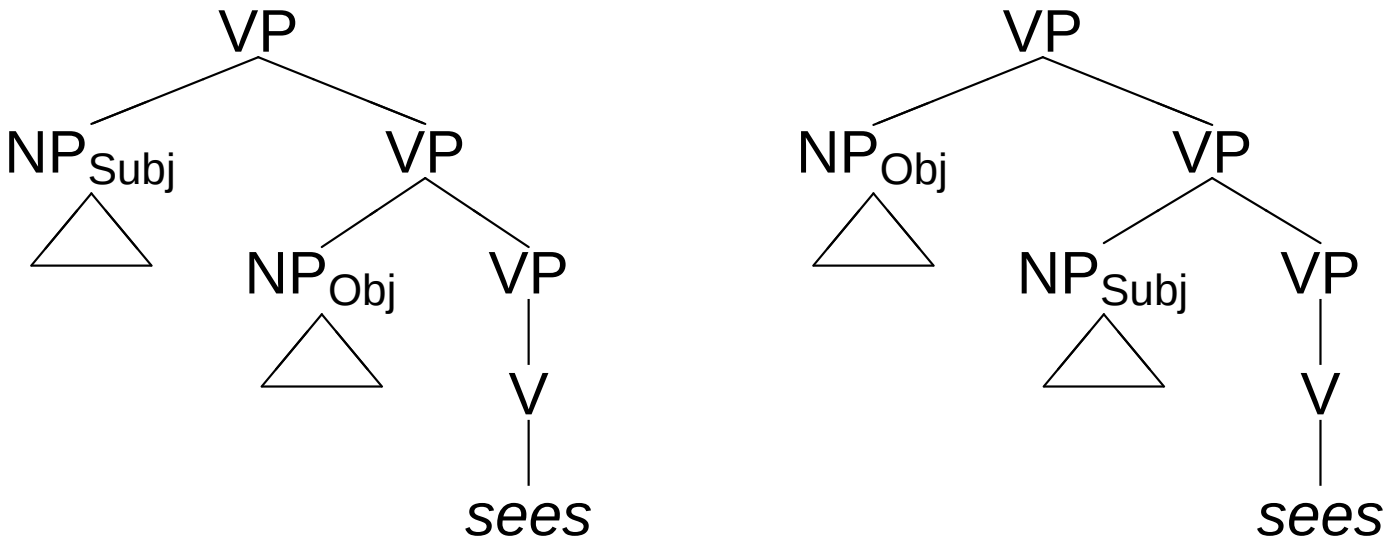
Scrambling in the Metagrammar

- Free order through underspecification

Metagrammar:



(Compiled) Grammar:



V2 – Methodology

Idea Basic V2 phenomenon is the same in all V2 languages: Topicalization

Our Approach Crosslinguistic generalizations are captured in one Metagrammar using different heads (verbs) (see Rambow and Santorini, 1995)

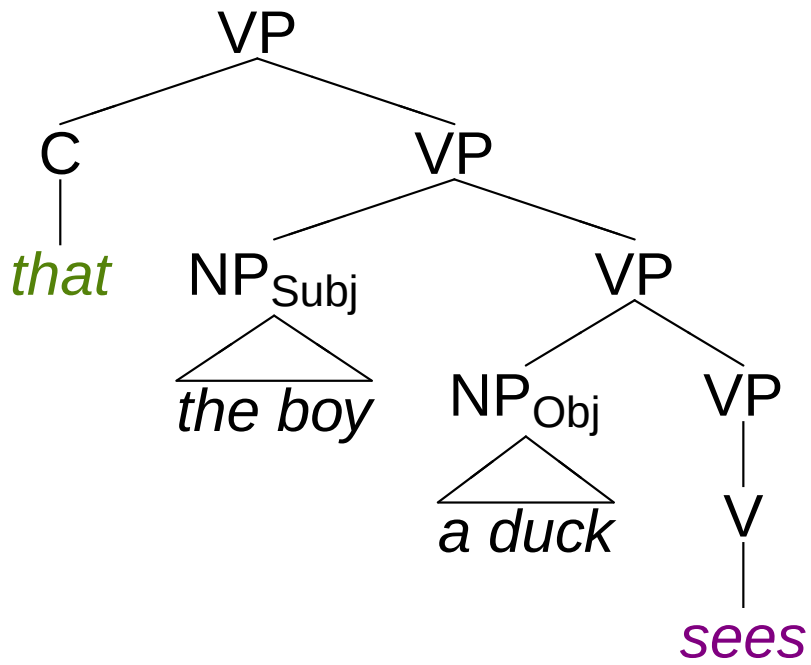
Major New Issue When Going Multilingual: Heads

- One language: relative position of verb and arguments determine word order
- Two languages: want language-independent generalizations about syntax; prototypical example: adverbs in English and French (Pollock):
  E: Charles (often) eats (*often) beans
  F: Charles (souvent) mange (souvent) des haricots
- Solution: verbal heads are in different positions on the projection in E and F, but adverb is always adjoined to the left of VP
- In some languages (like German and Yiddish), it is clear that verbs can be in different positions on the projection, anyway
- For some languages (Korean), there is very little evidence for this notion

Dealing With Word Order Variation in a Metagrammar

Verbal trees are determined by:

1. A subcategorization frame (e.g., intransitive/transitive)
2. Valency alternations (e.g., active/passive)
3. Argument realizations (e.g., wh-movement)
4. A topology, which encodes the position and characteristics of the verbal head



Topology

A topology is a combination of the projection and any compatible head(s).

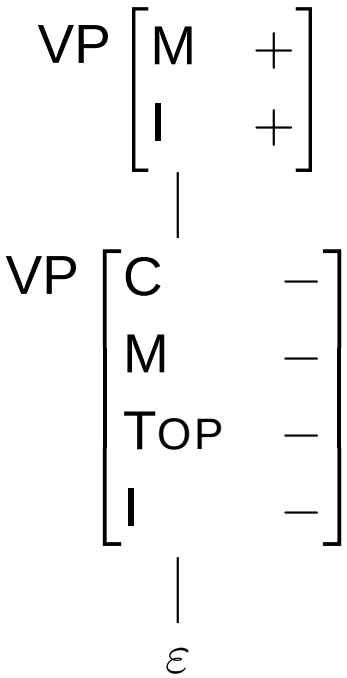
projection

- Empty verbal head plus its maximal projection
- Different types of clauses defined by features:
  - non-finite clauses: [I:−]
  - root V2 clauses: [Top:+]
  - finite clauses [M:+, I:+]

heads

- Introduce categorial features
- The list of possible heads differs from language to language

A Finite Projection



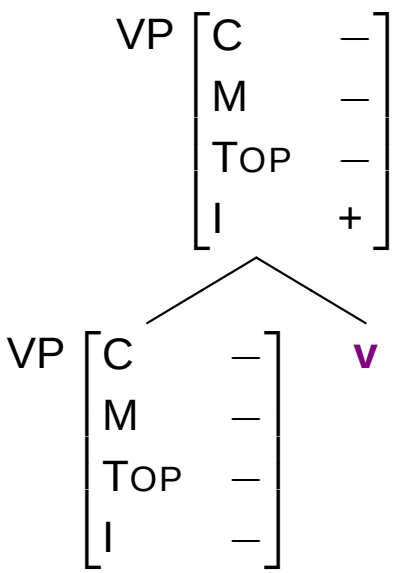
The Heads Define the Topology of Clauses

Properties of the verbal heads (feature inventory) determine the positions of arguments and adjuncts:

- I (finite tense and subject-verb agreement): creates a specifier position for agreement, but allows recursion (i.e., adjunction at IP)
- Top (topic): a feature which creates a specifier position for the topic and which does not allow recursion (used for V2)
- M (mood): a feature with semantic content (to be defined), but no specifier
- C (complementizer): a lexical feature introduced only by complementizers

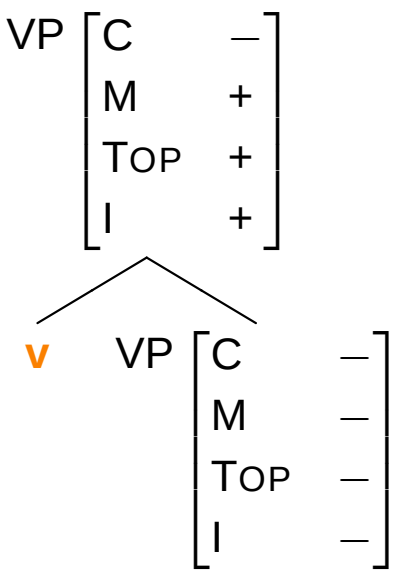
Some Simplified German Heads

1:



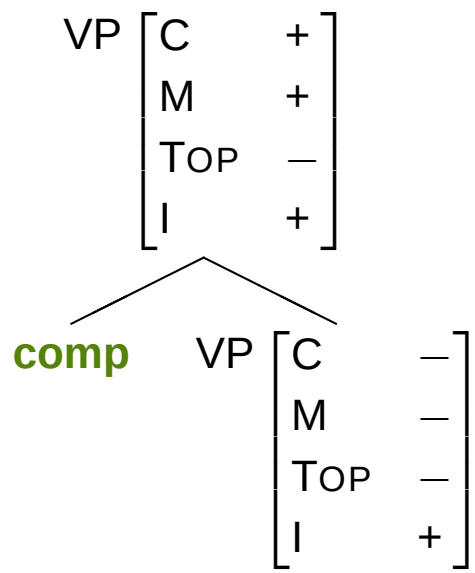
finite V-final

2:



V2-Subject

4:



Complementizer

German vs. Yiddish Heads

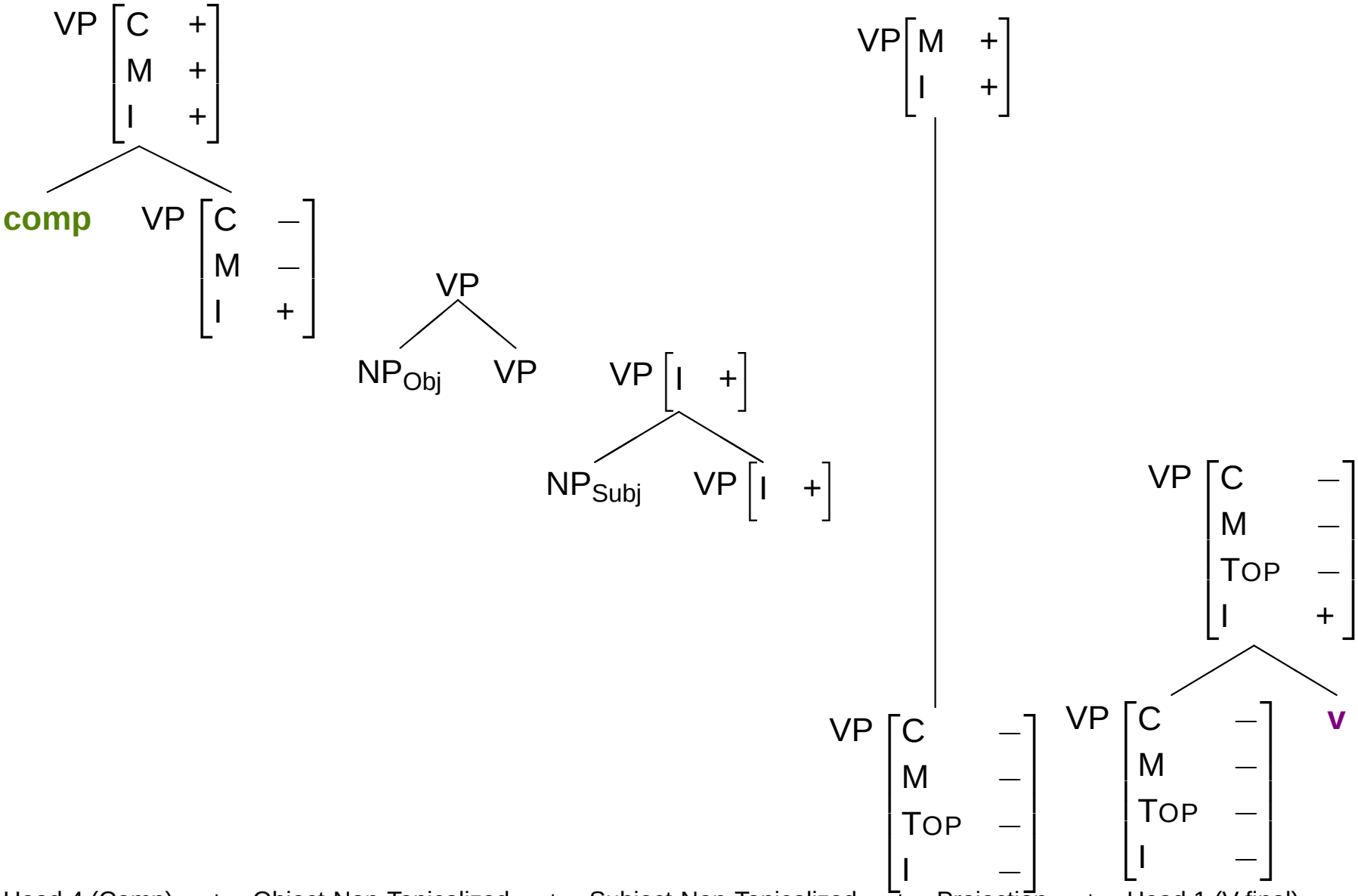
German:

	What	Features Introduced	Directionality
1	Verb (clause-final)	+I	head-final
2	Verb (V2, subject-inital)	+M, +Top, +I	head-initial
3	Verb (V2, non-subject-initial)	+M, +Top	head-initial
4	Complementizer	+C, +M	head-initial

Yiddish:

	What	Features Introduced	Directionality
1	Verb	+I	head-initial
2	Verb (V2, subject-inital)	+M, +Top, +I	head-initial
3	Verb (V2, non-subject-initial)	+M, +Top	head-initial
4	Complementizer	+C	head-initial

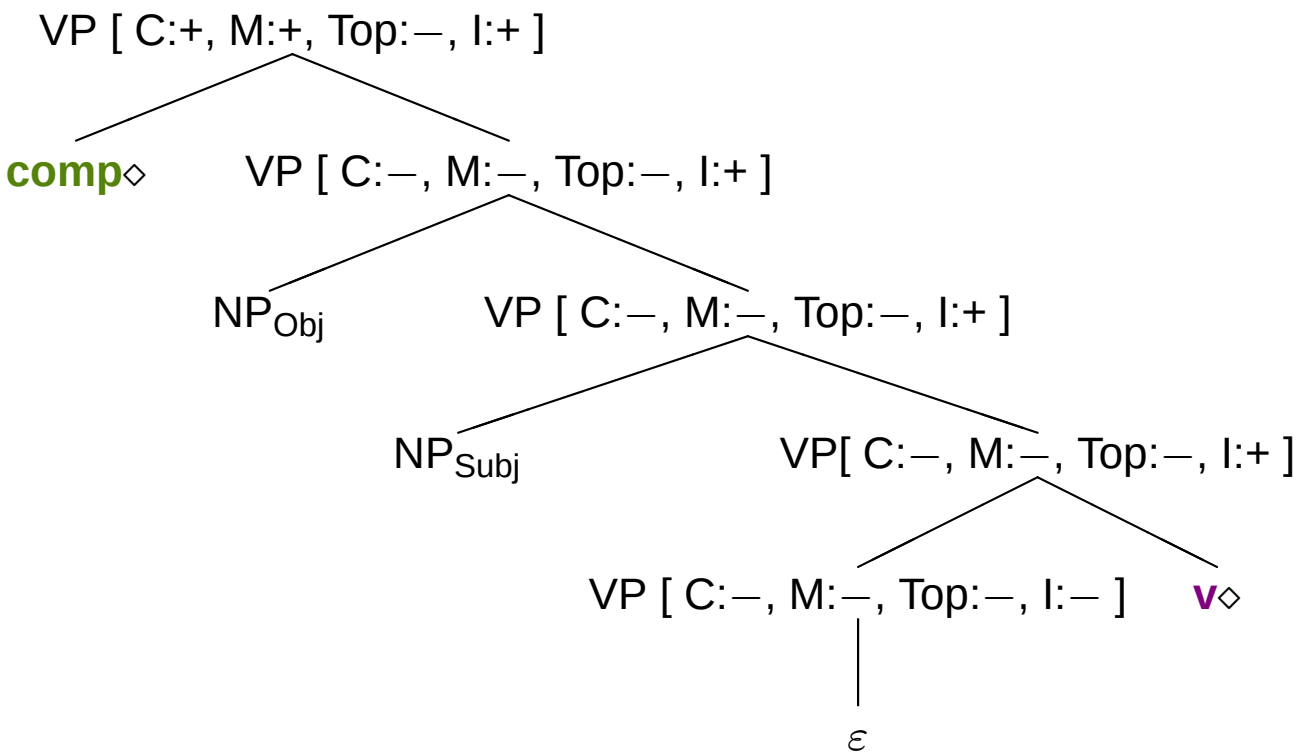
Derivation of a German sentence



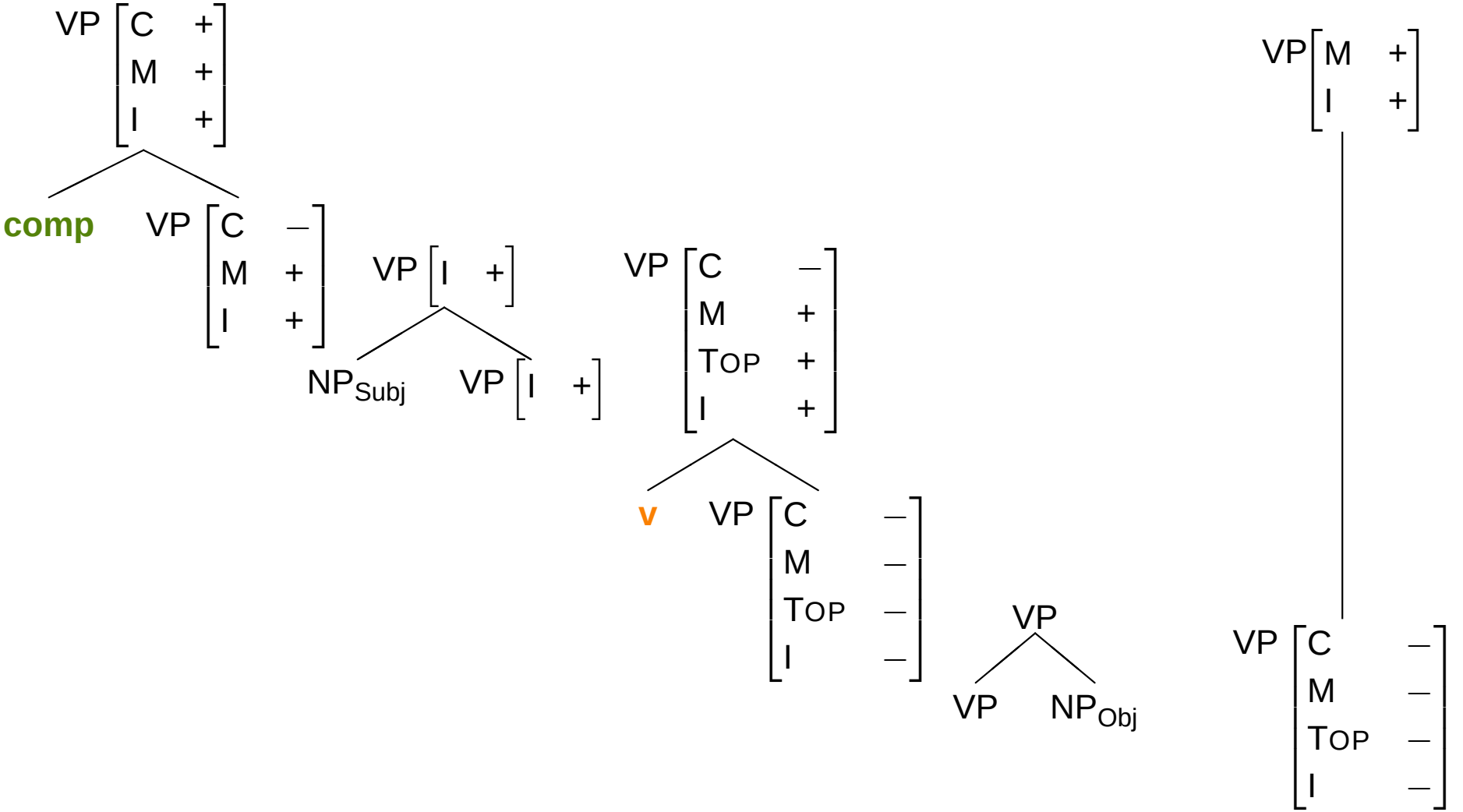
Head 4 (Comp) + Object-Non-Topicalized + Subject-Non-Topicalized + Projection + Head 1 (V-final)

that | a duck | a boy | ϵ | saw

Derived German Tree

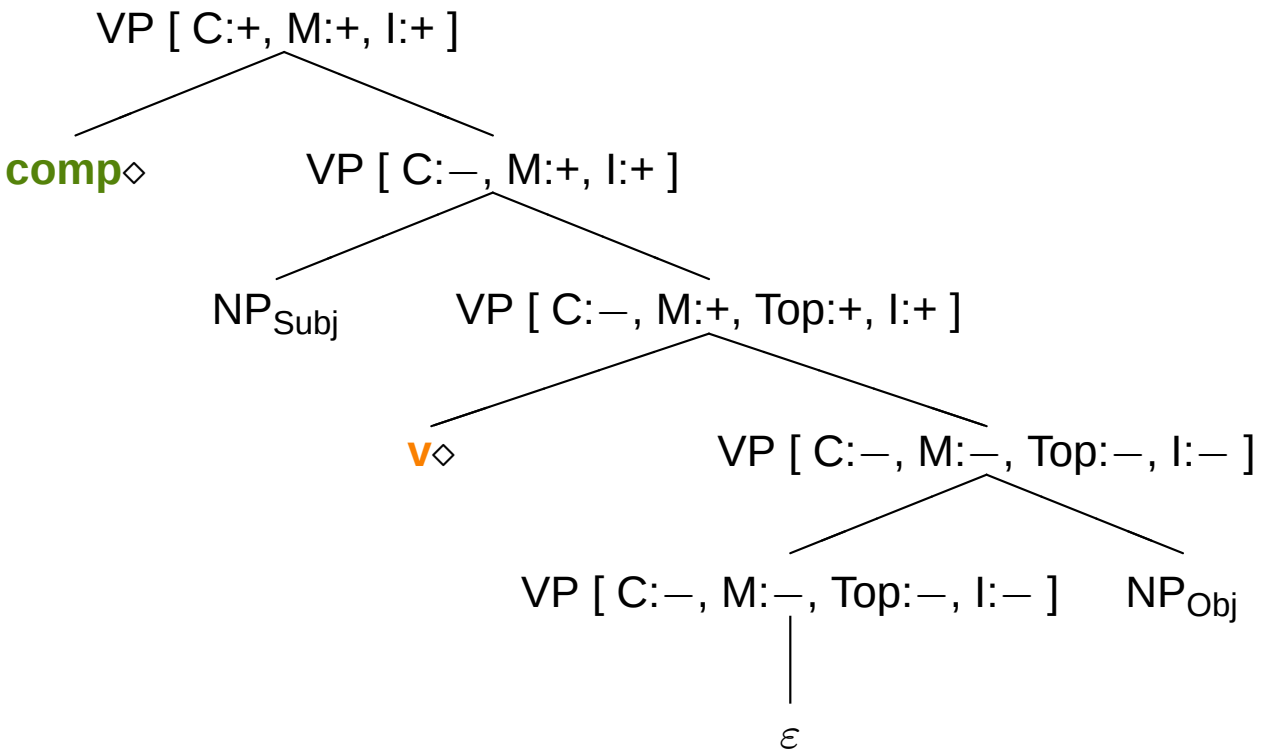


Derivation of a Yiddish Sentence



Head 4 (Comp)	+	Subject-Topicalized	+	Head 2	+	Object-Non-Topicalized	+	Projection
that		a boy		saw		a duck		ε

Derived Yiddish Tree



Outline

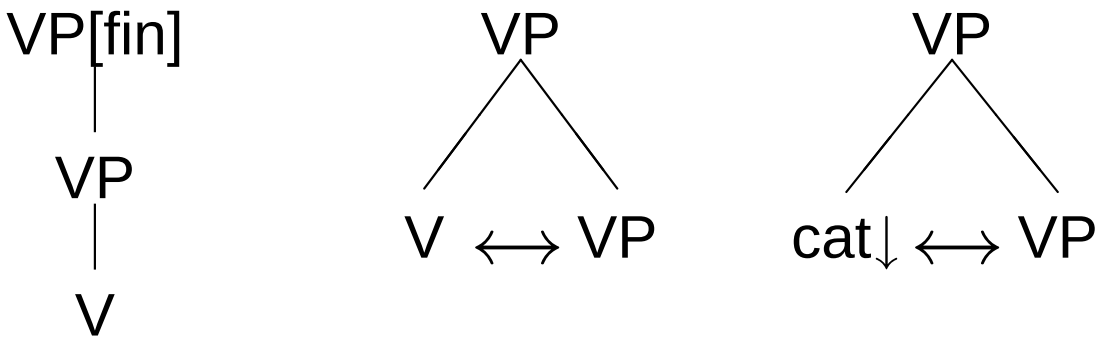
Conclusion

- Grammars are needed in virtually all CL applications
- Metagrammar captures common elements in and among grammars
- Ideal for representing cross-linguistic generalizations
- Korean, German and Yiddish look a lot alike in a metagrammar
- Very fast development of grammars for new languages is possible

Thank You!

Universal Grammar components

- A clausal tree is defined by a projection, a subcategorization frame, and a set of heads
- Category of the arguments, for example, is underspecified in the UG
- Head and its sister are not ordered in UG (double arrow)



Generic elements of Universal Grammar: projection, head, argument (from left to right)

UG components (2)

- Spec heads, non-spec heads
- specifier arguments, non-specifier arguments
- universal diathesis alternations: passive, causative